The earthquake impact on New Zealand's geodetic, boundary and topographic infrastructure | Know thy boundary impacts

Graeme Blick, Anna de Raadt, Nic Donnelly, Bjorn Johns, Ian Reese

Land Information New Zealand
Toitū te whenua

Introduction: |

Land Information New Zealand (LINZ) is a central government agency responsible for the management of property rights such as the survey and title system as well as location-based information such as geodetic, cadastral and topographic data sets.

Natural events such as earthquakes can impact not only infrastructure such as buildings and roads; cadastral boundaries and geodetic control points can be significantly affected. To maintain the integrity of the property rights system, these impacts have to be taken into account during the recovery process.

In an earthquake, horizontal and vertical movements can be very complex and varied

This is demonstrated in the recent earthquake sequence in Kaikoura in Images 1 and 2. Here we see vertical land movements up to about 6m and horizontal movements up to about 6m.

The extreme variations in both magnitude and direction present significant challenges in providing reliable and consistent geodetic control.

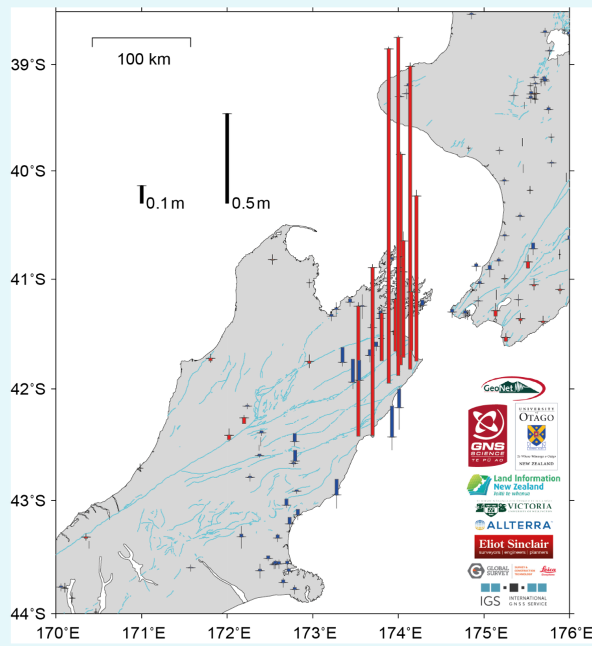

Image 1

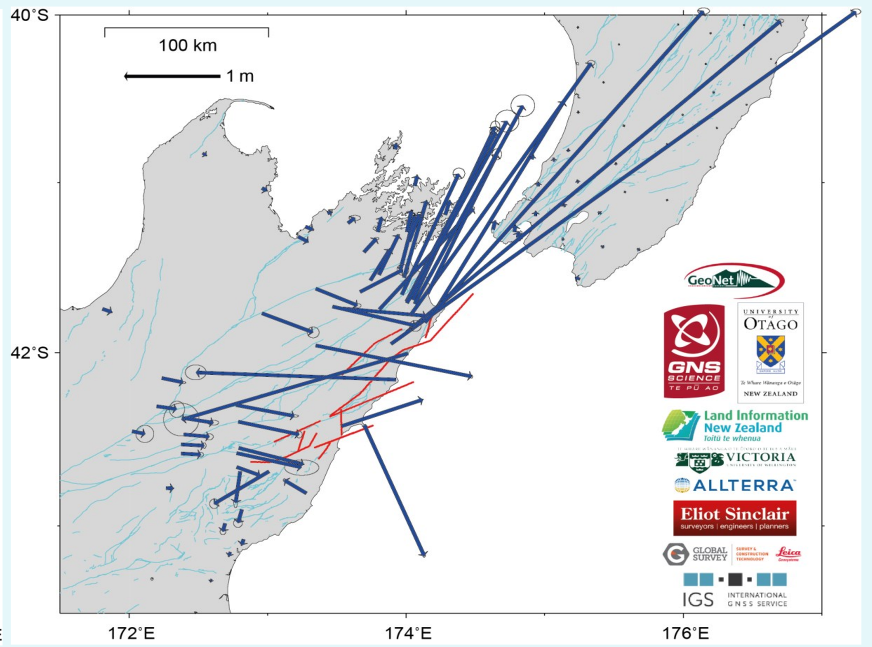

Image 2

Shallow movement or deep?

The various horizontal and vertical land movements in Blenheim shown in Image 3 are consistent across the built-up area. How these changes are taken into account when defining property boundaries depends on the nature of the movement – is it shallow or deep? The consistent displacement across this area means that, while property boundaries have moved, there is little differential movement between adjacent property boundaries.

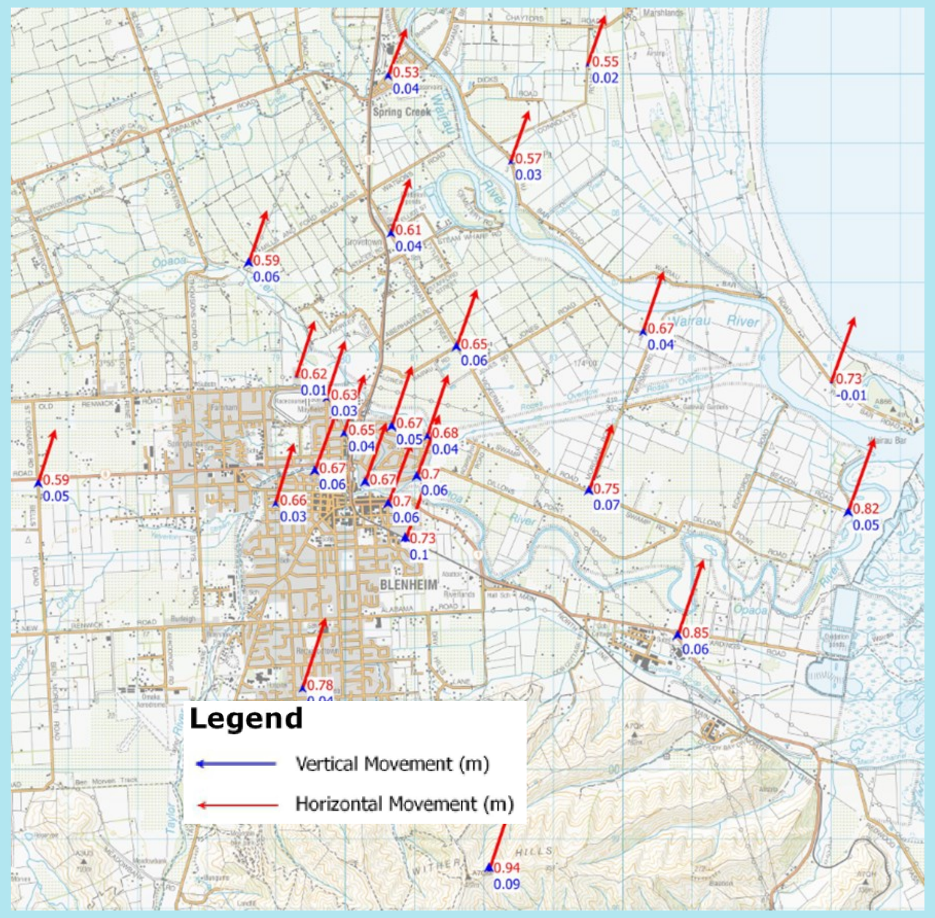

Image 3

The impact of deep-seated movements

Where a boundary has been affected by a deep-seated movement, normally a fault rupture, a boundary that was formerly a straight line may now include one or more angles due to shear or lateral distortion.

A boundary that moves with the earth will hold the same relationship to relevant physical evidence as it did prior to the earthquake. For example, a boundary that coincided with a fence line will continue to coincide with that fence line, as shown in Image 4.

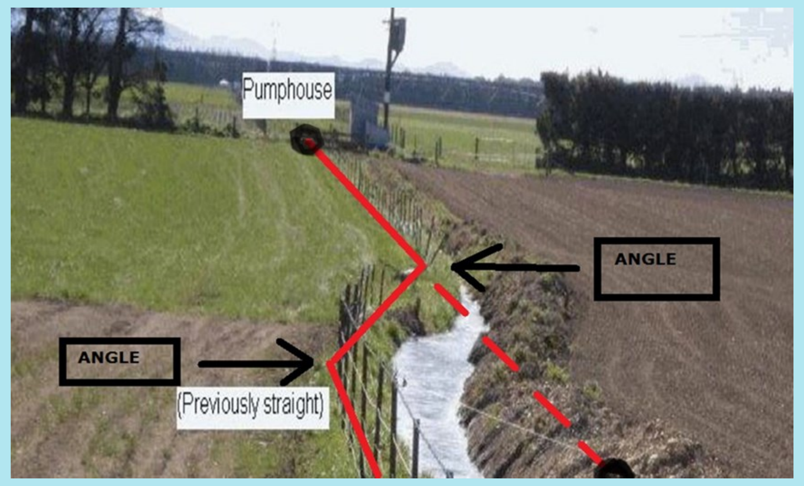

Image 4

Shallow movements

Shallow movements caused by earthquakes, for example lateral spread occurring along waterways due to liquefaction, are treated differently. The spreading caused by such an event can be seen in Image 5 where extension cracks indicating spreading can be seen near Lyell Creek. In such cases the boundary maintains its local relative position prior to the earthquake. In Canterbury, shallow movement was so extensive in parts of Christchurch that special legislation was passed to clarify the impact on property boundaries.

Image 5

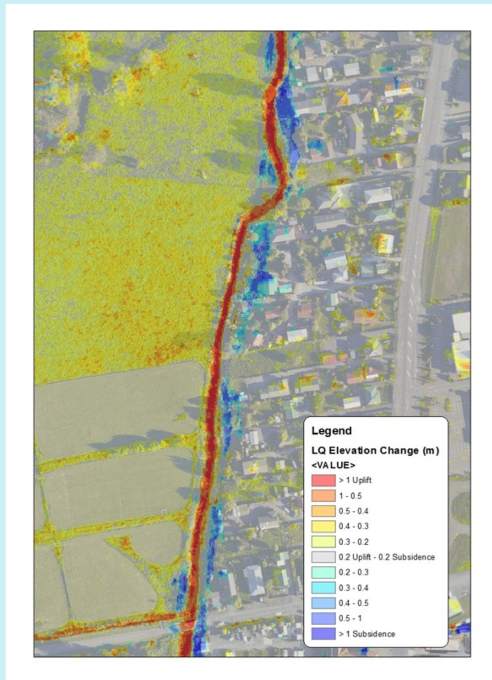

Image 6

Detecting and quantifying new slips

Earthquake events can also trigger shallow movements such as land slides. Image 7 demonstrates at a larger scale how LIDAR imagery taken before and after such events can readily identify and quantify change. Differencing the pre- and post-event data shows the disturbed areas – rock and soil deposit (red) and depletion (blue).

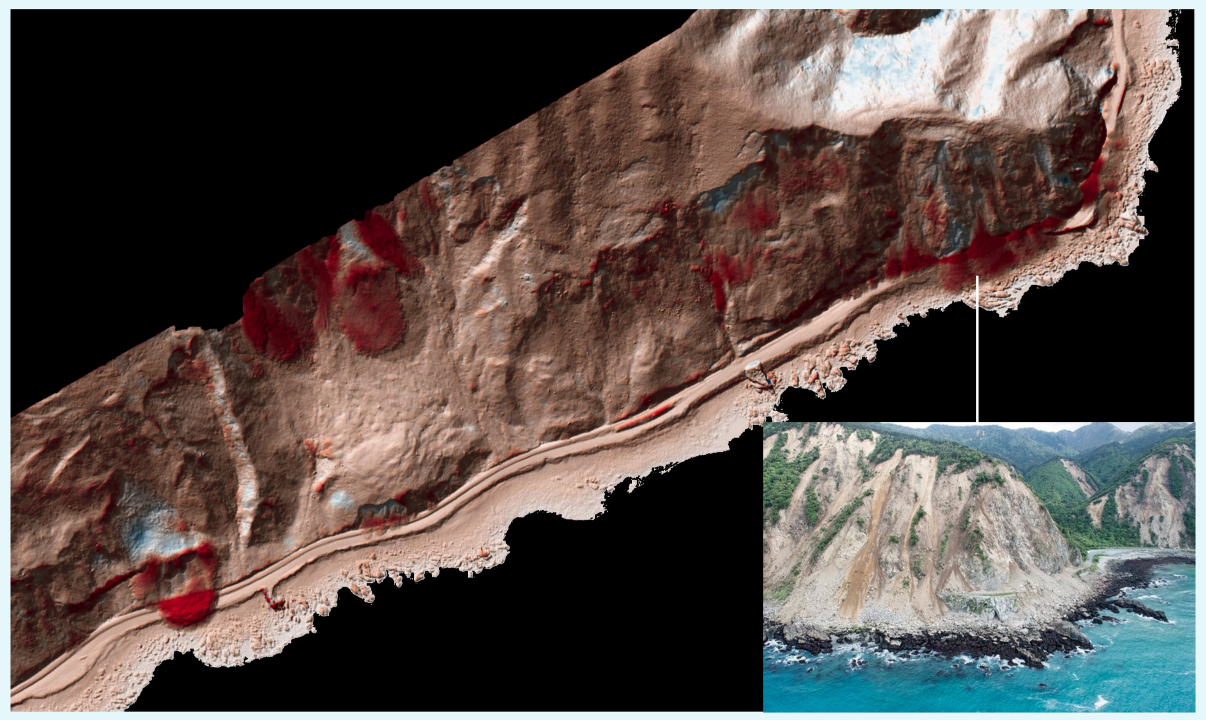

Image 7

Immediate need for post-event imagery

After Kaikoura, the NZ Transport Agency was facing the problem of how to get roads open again. They immediately captured post-event imagery and LIDAR shown in Image 8. When compared to earlier datasets from ECAN, new slips can be seen in the NZTA imagery and the fault scarp (curved vertical line in the NZTA imagery and LIDAR) clearly stands out. It also shows several metres of uplift, effectively new land that had arisen from the ocean.

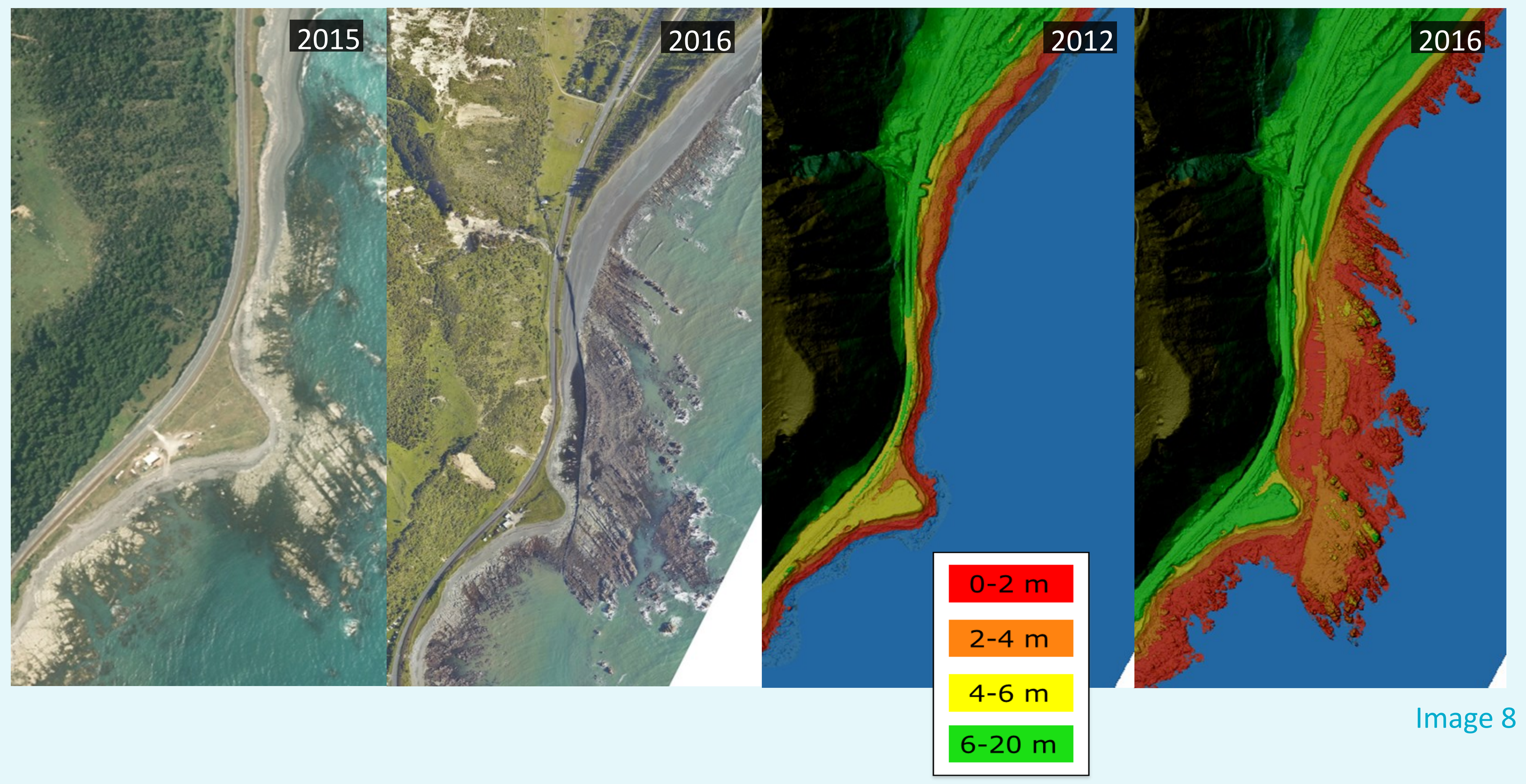

Image 8

Bathymetry adds further context

Additional context from bathymetric survey data collected by the Royal Australian Navy, clearly shows a localised block that popped up by several metres both on and off shore after the Kaikoura earthquake.

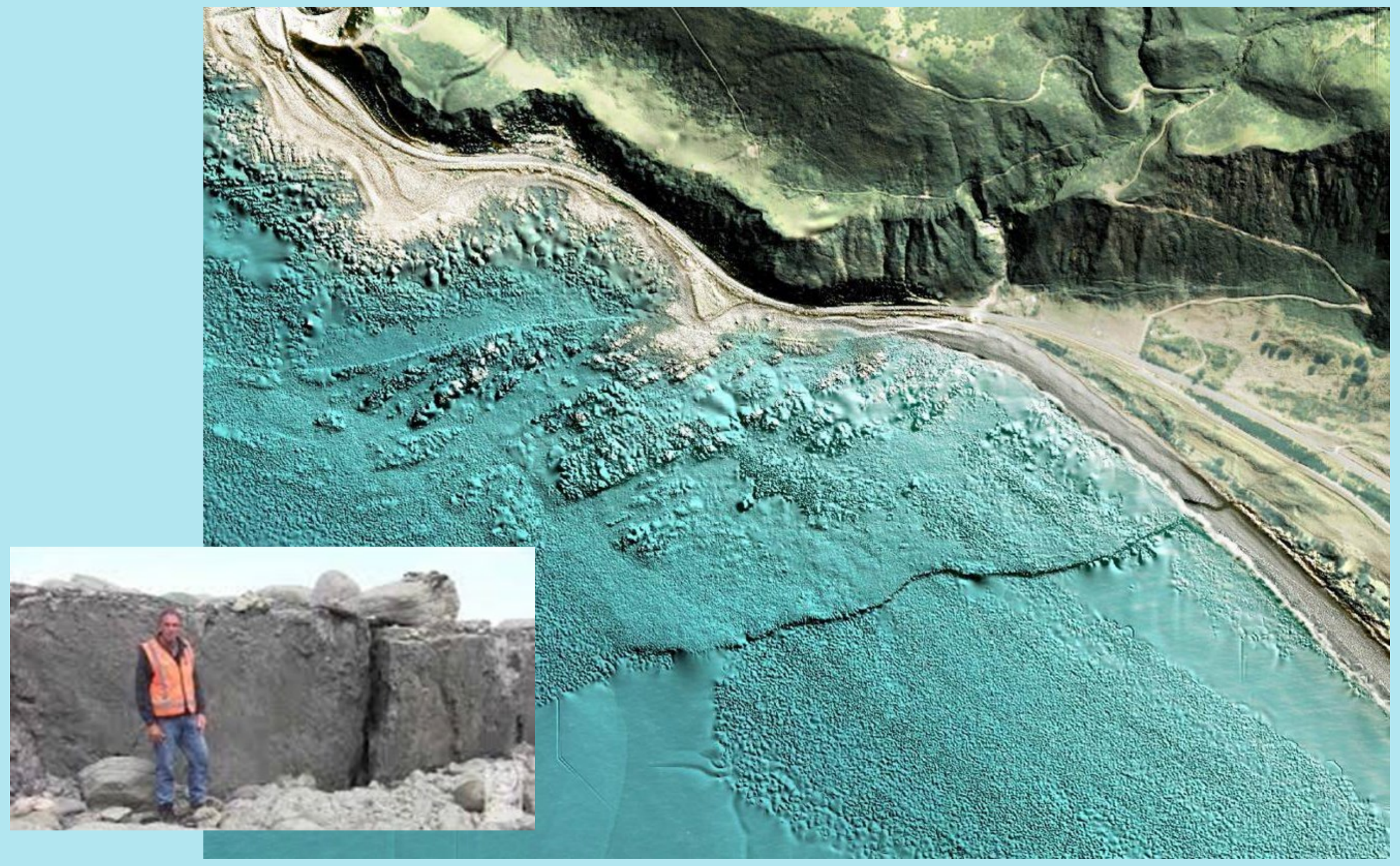

Image 9

Conclusion |

Earthquake events can impact not only infrastructure such as buildings and roads. Cadastral boundaries and geodetic control points can also be significantly affected and these need to be considered before rebuilding impacted infrastructure.